The Cell's Recharge

Trace how ATP and ADP transfer energy during muscle work.

BIO.2.1 "Use models to demonstrate that ATP and ADP are cycled within a cell as a means to transfer energy."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline one description of each change, ATP to ADP and ADP to ATP. Circle where energy enters and where it eventually leaves to check what cycles and what does not.

Climbing on Cell Power

1. Halfway up a staircase, your leg muscles keep shortening and relaxing. Inside each muscle cell, proteins called myosin pull on fibers to make contraction possible. Myosin needs a quick supply of usable energy. A molecule called ATP carries energy from one set of reactions to another. ATP has three phosphate groups; ADP has two. As myosin breaks ATP into ADP and a free phosphate, energy becomes available for myosin to change shape and pull. Some energy also spreads as heat. The cell cannot keep using the same ATP molecule without rebuilding it.

2. How does the cell rebuild ATP? During cellular respiration, a cell releases energy from food molecules. Some of that energy drives the attachment of a phosphate group to ADP, making ATP again. The rebuilt ATP can be used by proteins that need energy, including myosin. Picture a model with two linked changes: ADP plus phosphate becomes ATP when energy from food is supplied; ATP becomes ADP plus phosphate when cell work is powered. Arrows between these changes form a cycle for the molecules. Energy takes a different route: it enters from food and eventually leaves as heat.

3. As the climb gets steeper, muscle cells need more ATP each second. They do not solve this by storing an endless pile of ATP. Instead, they speed up the reactions that rebuild it from ADP and phosphate, as long as fuel and oxygen are available. If rebuilding slows while myosin keeps using ATP, less ATP is available for contraction. A useful model must show both directions of change, not a one-way line ending at ADP. It must also avoid a misleading loop for energy. ATP and ADP cycle within the cell, but energy must continually enter the system.

2 ANSWER WITH EVIDENCE

Use the passage

1. In a model of a working muscle cell, what change should an arrow from ATP show, and what work does that change help power?

2. What should an arrow returning from ADP to ATP show? Include the source of the energy needed for this change.

3. Suppose myosin keeps using ATP, but ATP rebuilding slows. Use the two changes in the model to explain what happens to the ATP available for contraction.

4. A student draws an energy arrow from muscle work back to food, making an energy loop. How should the energy arrows be changed to match the passage?

3 YOUR TURN

Your own words

Draw a labeled cycle showing how a cell uses ATP to build a new cell molecule and then rebuilds ATP using energy from food. Add arrows for phosphate and energy, and write one sentence explaining why your energy arrows do not form a cycle.

The Cell's Recharge

PART 1 · READ AND MARK

Underline one description of each change, ATP to ADP and ADP to ATP. Circle where energy enters and where it eventually leaves to check what cycles and what does not. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In a model of a working muscle cell, what change should an arrow from ATP show, and what work does that change help power?	**ATP becomes ADP plus a free phosphate, making energy available for myosin to change shape and pull.**
2	What should an arrow returning from ADP to ATP show? Include the source of the energy needed for this change.	**A phosphate group attaches to ADP to make ATP, using energy released from food during cellular respiration.**
3	Suppose myosin keeps using ATP, but ATP rebuilding slows. Use the two changes in the model to explain what happens to the ATP available for contraction.	**ATP continues changing to ADP faster than ADP is rebuilt into ATP, so less ATP is available for contraction.**
4	A student draws an energy arrow from muscle work back to food, making an energy loop. How should the energy arrows be changed to match the passage?	**Show energy entering from food and eventually leaving as heat. Do not draw energy cycling back from muscle work to food.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Drawing: ADP + phosphate → ATP, with energy entering from food; ATP → ADP + phosphate, with energy supplied to build a cell molecule; ADP and phosphate return to the first change. Sentence: Energy enters from food and eventually leaves as heat, so it does not cycle.

Accept models that show ATP becoming ADP plus phosphate during cell work and ADP rejoining phosphate using energy from food. Energy must enter and eventually leave, rather than cycle with ATP and ADP.